

Solid Earth

ES-3 The student will demonstrate an understanding of the internal and external dynamics of solid Earth.

ES-3.7 Classify minerals and rocks on the basis of their physical and chemical properties and the environment in which they were formed.

Taxonomy level: 2.3-B, C Understand Conceptual-Procedural Knowledge

Previous/future knowledge: Students in 3rd grade (3-3.1) classified rocks into one of the three types based on physical properties and identified minerals (3-3.2) by properties on an identification key. In 8th grade (8-3.4) the three rocks types were explained through the rock cycle and the importance of minerals (8-3.5) summarized based on physical and chemical properties. Students have not classified mineral or rocks using an identification process.

It is essential for students to know the processes and properties that allow for mineral identification and rock identification. They should be able to use mineral and rock identification keys/charts.

Mineral Identification:

Geologists rely on several relatively simple tests to identify minerals. These tests are based upon a mineral's physical and chemical properties. By using the results from a combination of tests rather than just one, the mineral's classification and identity is more accurate. Comparing test results from the mineral sample with known properties of minerals from a mineral identification chart increases the accuracy of the identification.

Mineral identification properties and tests students should be able to perform include:

- color,
- luster,
- texture,
- streak,
- hardness, and
- cleavage & fracture.
- Density tests may also be performed if the right equipment is available. Heft (heaviness compared to sample size) is sometimes used as a relative density description.
- Some minerals have special properties that are useful in identification, such as reaction with acid, magnetic attraction, or light refraction in transparent or translucent minerals.

Rock Identification:

Rocks are made up of minerals and are formed very differently, therefore their identification and classification is fairly complicated. Geologists must analyze mineral composition, evidence of type of formation, and size & arrangement of minerals to determine the classification of rocks. After basic information is gathered on a specific rock to determine its major rock type and classification, properties on a rock identification chart can be used to identify the specific rock sample.

Rock identification properties and tests students should be able to perform include:

- For ***igneous*** rocks – determine if the igneous rock is *intrusive* or *extrusive* based on - texture (fine-grained, coarse grained, glassy crystal size); composition of minerals (using common minerals such as quartz, feldspar, mica, hornblende).
- For ***metamorphic*** rocks – determine if the metamorphic rock is *foliated* or *nonfoliated* based on – texture (layers or bands of minerals, not banded); coarse-grained or fine-grained
- For ***sedimentary*** rocks – determine if the sedimentary rock is *clastic*, *organic*, or *chemical* based on – evidence of sediment particles/grains (coarse-grained, medium-grained, fine-grained) cemented together; evidence of once-living material (shells, plants/carbon,); evidence that the material could have been precipitated or settled out of water or was evaporated from solution.

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The properties of the rocks also give clues to the environment in which they were formed.

- Intrusive igneous rocks with their larger crystals were formed deep inside Earth where slow cooling could take place. Small grained or glassy texture of extrusive igneous rocks indicates rapid cooling at Earth's surface with little to no time for crystals to grow.
- The grade of metamorphic rock is dependent upon a combination of factors including pressure on the rocks, the temperature, and the depth below the surface.
- Clastic sedimentary rocks with particles that are rounded are evidence of water transported materials while angular fragments indicated little transport or possibly wind born.
- Changes in river level or sea level may result in stratification of sedimentary rock layers.

It is not essential for students to do further classification of minerals into groups/families or to identify specific mineral crystal systems. The composition or origin of magma or the process of crystallization is not essential, although students may find crystal growing an interesting activity. Further classification of igneous, metamorphic, or sedimentary rocks beyond the main grouping is not necessary.

Assessment Guidelines:

The objective of this indicator is to *classify* minerals and rocks; therefore, the primary focus of assessment should be to use physical and chemical properties of minerals and of rocks to determine which category the sample belongs and also the environment in which it was formed.

In addition to *classify* appropriate assessments may require students to:

- *identify* a mineral property based on its description;
- *explain* how the formation environment affects crystal size or grain texture; or
- *interpret* information on a mineral or rock identification chart.